SUSTAINABLE STRATEGY OF HEALTH AND SAFETY ASSESSMENT IN HIGH RISE COMMERCIAL BUILDINGS

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Abstract: In Malaysia scenario, various obstacles have to be faced by the building maintenance teams controlling all activities related to the high rise office building and its system. The crucial issue is to face serious problems with health and safety aspect of the building. This study aims to evaluate the health and safety performance of high rise office buildings, using a basic assessment method. An assessment method based on a hierarchy of building performance indicators concerning the quality of design factor and management factor with five attributes such as architectural design, building services design, the surrounding environment, operation and maintenance, and facilities management. Eleven high rise office buildings were randomly selected in Klang Valley, Malaysia and assessed through site inspections, desk searches, and interviewed facilities management personnel (FM), outsourced contractors/consultants (OS), building owners (BO) as well as (T) tenants. A performance analysis was conducted to examine and compare the overall health and safety performance of the buildings. The results had shown that there were significant variations in health and safety conditions across buildings, although they are situated within a single locality. After describing the current situation and problems, this paper concludes that most of the variations in building health and safety conditions were attributed to differences in building management systems rather than building designs. It is envisaged that further research can be conducted to investigate the relationship between building performance and extraneous factors, such as building age, management structure, and scale of development.

Keywords: Health; High Rise Office Building; Safety

INTRODUCTION

In Malaysia scenario, various obstacles have to be faced by the building maintenance teams controlling all activities related to the high rise commercial building and its system. The crucial issue is to face serious problems with health and safety aspect of the building. Bubshait and Almohawis (1994) defined health and safety as the degree to which the good conditions all the time without major accidents of injuries to building public. Ad Straub (2002a) opined that maintenance personnel need to secure health and safety performance in maintenance work, which has definite precedence over work for aesthetic or sustainable reasons. This was supported by Love and Edwards (2004), who considered that safety is a significant factor that contributes to building performance, and thus must never be compromised.

According to Liias (1998), Jamila (1994), Malaysia Government (1999), Sapian (2003), Tiun (2006) and Eddy (2004a), the most challenging issues in the high rise buildings were health and safety aspect which related to operation and maintenance activities. Furthermore, Linariza and Ashok (2003) found that after the buildings have been occupied, facilities management became an issue including health and safety aspect.

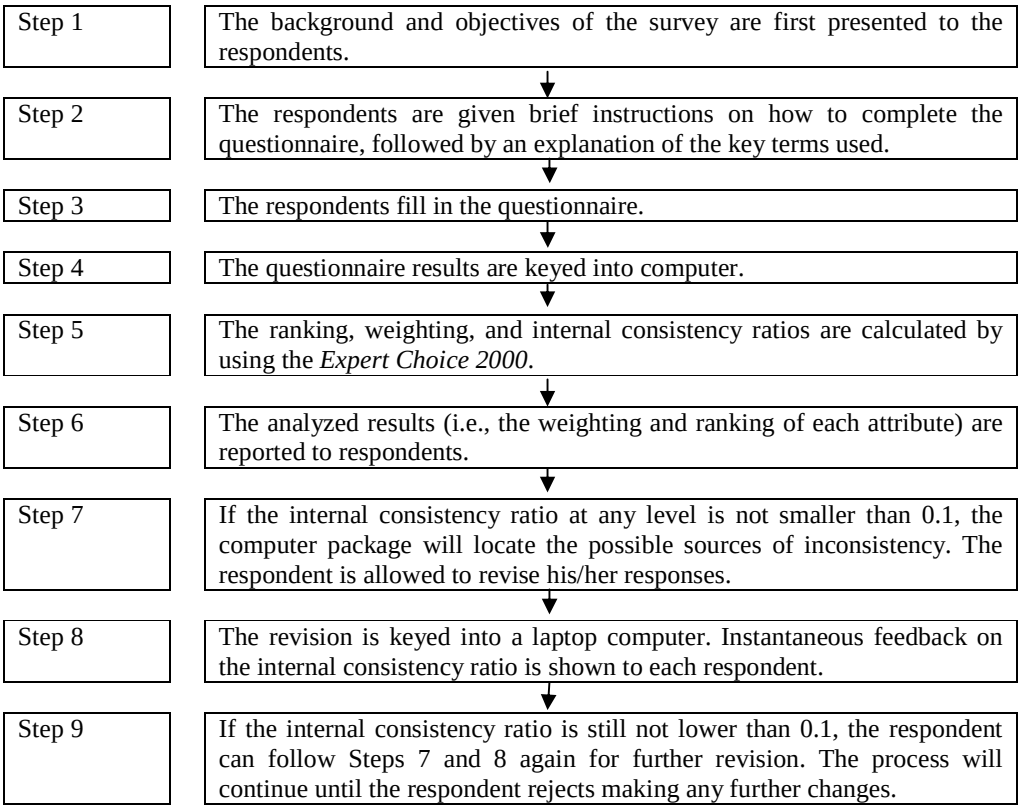

Figure 1: A flowchart showing the procedures of the BHHI and BSCI

In addition, building occupants complained through the mass media and the issues were always about health and safety as well as disputes between maintenance teams and them. Even so, the management gap continued to exist as referred to the on-going issues reported in mass media (Tiun, 2006). Building occupants, tenants as well as end-users continued to complain about the health and safety in the high rise commercial buildings as well as the responsibility of maintenance teams in ensuring the buildings are in good condition all the time. Moreover, health and safety problems have a stronger spillover effect in a high-density setting than a low-density one a building with poor health and safety conditions not only adversely affects its occupants, but also jeopardizes those occupying and working in the building.

RESEARCH OBJECTIVE

This study aims to assess the health and safety performance of high rise commercial buildings, using a basic assessment method since health and safety are among the most challenging aspects in the particular buildings. Since health and safety are the most important aspects to the building occupants, the present research focus to determine health and safety aspects and do assessment based on a hierarchy of building performance indicators concerning the quality of design factor and management factor with five attributes such as architectural design, building services design, the surrounding environment, operation and maintenance, and facilities management through perception of various background of building stakeholders to the existing building. The research, therefore, contributes to the revelation of hidden building information to the occupant as well as parties who related to design and management of the high rise commercial buildings in order to improve more sustainable commercial area.

Table 1: Building factors assessed under the BHHI and BSCI, and their relative weightings

	Level 1		Level 2		Level 3	
		Weight (%)	Category	Weight (%)	Building factor	Weight (%)
BHHI						
	Design	45.5	Architecture	15.0	Size	1.8
					Plan shape	2.5
					Master Bedroom	1.8
					Windows	4.8
					Noise reduction	3.3
					Open space	0.8
			Building Services	17.3	Water supply	4.8
					Drainage	6.8
					Refuse disposal	3.3
					Lift	2.4
			External Environment	13.2	Density	1.6
					Adjacent use	1.5
					Air quality	4.7
					Aural quality	2.0
					Visual obstruction	1.2
					Thermal comfort	2.2
	Management	55.5	Operations & maintenance	29.5	Cleaning	5.6
					Pest control	3.3
					Refuse handling	4.8
					Drainage condition	4.8
					Unauthorized alteration	4.5
					Water quality	6.5
			Management approaches	26.0	Facilities Management Teams' duties	8.7
					Documentation	7.8
					Emergency preparedness	6.5
					Financial arrangement	3.0
BSCI						
	Design	46.0	Architecture	21.0	Height and disposition	3.5
					Means of escape	8.0
					Means of access	6.5
					Amenities	3.0
			Building services	16.5	Fire service installations	8.5
					Electrical installations	4.2
					Fuel supply	3.8
			External environment	8.5	Proximity to special hazards	6.5
					Proximity to fire station	2.0
	Management	54.0	Operations & maintenance	34.5	Structural condition	8.3
					Building services condition	6.4
					Exit routes condition	8.4
					Fire compartment	4.5
					Illegal appendages	6.9
			Management	19.5	Facilities Management	4.2

			approaches		Teams' duties	
					Documentation	3.8
					Emergency preparedness	7.7
					Financial arrangement	3.8

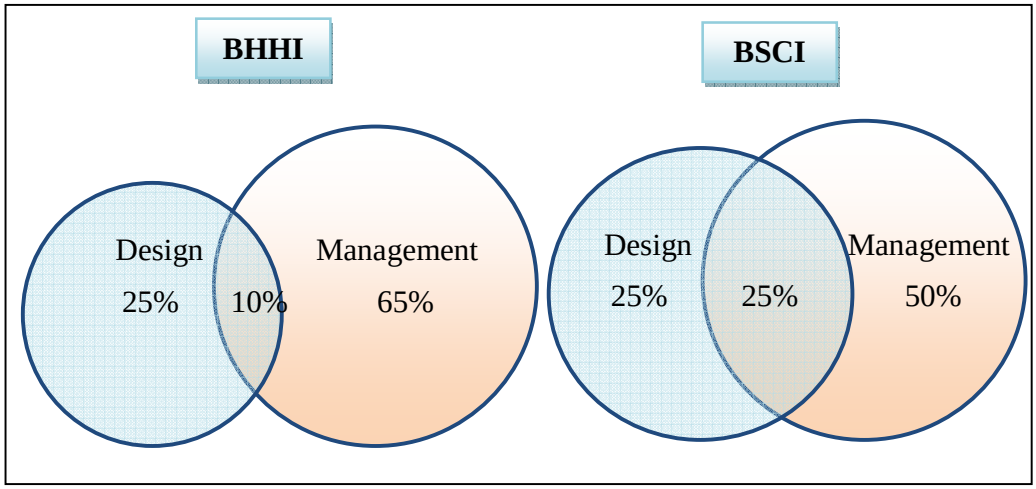

Figure 2: Contributions of design and management factors to variations in the BHHI and BSCI

RESEARCH METHOD

Figure 1 illustrates a flowchart of a research based on Ho et al. (2004) simple assessment framework. There were eleven high rise office buildings in Klang Valley, Malaysia have been randomly surveyed. Research also extended Ho et al. (2004) health assessment framework to building safety. To make the survey results more comprehensible to the public, the research has translated technical performance details into indices (e.g. a health index and a safety index) for building classification. With these indices, the public and building owners can easily know the health and safety performance of buildings.

The research method was organized which include site inspections, desk searches and interviewed FM, OS, BO as well as T. Two assessment schemes such as Building Health and Hygiene Index (BHHI) for health and Building Safety and Conditions Index (BSCI) for safety were developed which based on the theoretical assessment framework introduced by Ho et al. (2004). This assessment model is in line with the ideology of the assessment model developed by Kim et al. (2005), which was designed for existing buildings with various degrees of quality. There are 26 factors for the BHHI and 18 factors for the BSCI. The weightings of the factors were assessed by two expert panels by using analytic hierarchy process (AHP) (Saaty, 1982).

The respondents' weightings of the different factors were extracted from a pair wise comparison of the relative importance of all pairs of factors at the same level as the hierarchy using the AHP computer package Expert Choice 2000. To compute the rating of each building factor in the assessment scheme, one would normally use a continuous scale ranging from the best practice (rating = 1) to the worst practice (rating = 0).

Defining health and safety

Ho et al. (2004) pointed out some characteristics that a healthy building should have: (a) A healthy building should not be too densely populated; (b) Its window design and layout should facilitate natural ventilation and diffusion of daylight; (c) It should be isolated from noise and air pollution sources; (d) Its water supply and waste systems should be appropriately installed, maintained, and managed; and (e) Its environmental conditions should be clean and hygienic.

Ho et al. (2004) was defined a safe building as one that minimizes the risk of physical injury and the death of occupants, such as evacuating them

effectively should emergencies arise. Hence, a safe building should have the following characteristics: (a) a structurally sound construction design and condition; (b) properly installed and maintained electrical and gas supply systems; (c) a design that facilitates the evacuation of occupants in case of emergency; and (e) a location that is less prone to flooding or landslides.

RESULT AND DISCUSSION

Overall Results

Table I showed the raw data have been collected and converted into a set of performance indicators that represent the health and safety conditions of each factor. The analysis of the assessment results will contribute to the key factors that influence the variations in the health and safety performance of the high rise office buildings.

$$\mathrm{BHHI}_k = \sum_{i=1}^{n} W_{H,i} F_{H,ik}, \quad \text{Equation 1(a)}$$

$$\mathrm{BSCI}_k = \sum_{i=1}^{ns} W_{S,i} F_{S,ik}, \quad \text{Equation 1(b)}$$

The distributions of BHHI and BSCI after the application of Equation (1a) and Equation (1b) to each building, the median BHHI and BSCI scores were 45% and 55%, respectively. Specifically, the BHHI ranged from 45% to 56%, whereas the BSCI ranged from 40% to 55%. Since the indices are building-specific, the health and safety performance of every building, it can be compared to the others. The stakeholders can use these results to know whether a building outperforms or underperforms. Homebuyers as well as FM also can use the data to ascertain the performance of building before they make their decisions.

Performance Attribution

A variance disintegration analysis was conducted to tell the relative significance of the first level factors (design and management) in affecting the dispersion of the BHHI and BSCI. Buildings differ, at most, by 30% for the BHHI and 35% for the BSCI.

By definition, the BHHI and BSCI are the weighted sums of the design index (DI) and the management index (MI), respectively. In other words:

$$\mathrm{BHHI}_k = w_{H,D}\,\mathrm{DI}_{H,k} + w_{H,M}\mathrm{MI}_{H,k}, \quad \text{Equation 2(a)}$$

$$\mathrm{BSCI}_k = w_{S,D}\,\mathrm{DI}_{S,k} + w_{S,M}\mathrm{MI}_{S,k}, \quad \text{Equation 2(b)}$$

Figure 2 summarized the results in Venn diagrams. 65% of variations in BHHI are merely attributable to management factors, suggesting that management factors dominate design factors in differentiate healthy buildings from the relatively less healthy ones. Only 10% of variations due to their co-movements were very low and insignificant. In BSCI, pure design factors contributed 25% to the total variation, while pure management factors contributed 50%. Similar to its health counterpart, pure management factors are more influential than pure design factors in affecting the variations in safety performance. In other words, most of the variations in building health and safety conditions were attributed to be difference in building management rather than building design. So, FM should improve health and safety performance by enhancing management. However, as oppose d to the BHHI's results, the co-movement of design and management factors occupies quite a significant share, being responsible for 25% of the variations in the BSCI. A probable rationale for such a strong co-movement is that design and management factors are determined by some ordinary factors, especially building age.

CONCLUDING REMARKS

There were significant variations in health and safety environments in high rise commercial buildings, although they are located in the same region. In addition, most of the variations in building health and safety conditions were attributed to differences in building management systems rather than building designs.

Improvement of facilities management system particularly in operation and maintenance processes (e.g. planned and unplanned maintenance as well as building policy requirement) is necessary in order to sustain health and safety aspects in the building. Neglecting and tolerating poor building health and safety conditions could now make a higher cost of maintenance aspect in the future. The future building occupants, tenants and also end-users can simply assess the building condition through summarizing into BHHI and the BSCI as the user-friendly performance indicators for their consideration. By publicizing these performance indices, the public would be better informed of the health and safety risks of different buildings. It is envisaged that further research can be conducted to investigate the relationship between building performance and extraneous factors, such as building age, management structure, and scale of development.

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